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the documents attached hereto are true copies of the Forms P2, P6, provisional specification and drawings of South African Patent Application No. 2002/5663 in the name of Potgieter Johannes Hermanus

Filed	:	16 July 2002
Entitled	:	Fuel Theft Detection system and Method

Geteken te / Signed at PRETORIA in die Republiek van Suid-Afrika, hierdie / in the Republic of South Africa, this 4th dag van / day of **September 2003**

Registrateur van Patente

BEST AVAILABLE COPY

FORM P.2

REPUBLIC OF SOUTH AFRICA	REGISTER OF PATENTS	PATENTS ACT, 1978

OFFICIAL APPLICATION		LODGING DATE: PROVISIONAL		ACCEPTANCE DATE	
21	01 2002/5663	22	16 JUL 2002	47	
INTERNATIONAL CLASSIFICATION		LODGING DATE: COMPLETE		GRANTED DATE	
51		23			

FULL NAME(S) OF APPLICANT(S)/PATENTEE(S)

71 POTGIETER, JOHANNES HERMANUS
~~FOURIE, PATRICK DESMOND~~

APPLICANTS SUBSTITUTED:		DATE REGISTERED
71	POTGIETER, JOHANNES HERMANUS	14·07·2003

ASSIGNEE(S)		DATE REGISTERED
71		

FULL NAME(S) OF INVENTOR(S)

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PRIORITY CLAIMED	COUNTRY		NUMBER		DATE	
N.B. Use International abbreviation for country (see Schedule 4)	33	NIL	31	NIL	32	NIL

TITLE OF INVENTION

54 FUEL THEFT DETECTION SYSTEM AND METHOD

ADDRESS OF APPLICANT(S)/PATENTEE(S)

1. 268 YORK AVENUE, FERNDALE, RANDBURG, 2118, GAUTENG, SOUTH AFRICA
2. 114 RAE FRANKEL STREET, BRACKENDOWNS, ALBERTON, GAUTENG, SOUTH AFRICA

ADDRESS FOR SERVICE		S & F REF
74	SPOOR & FISHER, SANDTON	PA133530/P

PATENT OF ADDITION NO.		DATE OF ANY CHANGE
61		
FRESH APPLICATION BASED ON		DATE OF ANY CHANGE

SPOOR & FISHER

REPUBLIC OF SOUTH AFRICA REVENUE FORM P.1

REPUBLIC OF SOUTH AFRICA
PATENTS ACT, 1978

APPLICATION FOR A PATENT
AND ACKNOWLEDGEMENT OF RECEIPT 16.07.02
(Section 30 (1) – Regulation 22)

R 0060.00

HASR 711

The granting of a patent is hereby requested by the undermentioned applicant on the basis of the present application filed in duplicate

REPUBLIEK VAN SUID AFRIKA

OFFICIAL APPLICATION NO.			S & F REFERENCE
21	01	2002/5663	PA133530/P

FULL NAME(S) OF APPLICANT(S)

AANSOEKERS VERVANG APPLICANTS SUBSTITUTED 14.07.2003

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ADDRESS(ES) OF APPLICANT(S)

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TITLE OF INVENTION

54	FUEL THEFT DETECTION SYSTEM AND METHOD

THE APPLICANT CLAIMS PRIORITY AS SET OUT ON THE ACCOMPANYING FORM P.2. THE EARLIEST PRIORITY CLAIM IS:

COUNTRY: NIL	NUMBER: NIL	DATE: NIL

~~THIS APPLICATION IS FOR A PATENT OF ADDITION TO PATENT APPLICATION NO.~~

21	01	

~~THIS APPLICATION IS A FRESH APPLICATION IN TERMS OF SECTION 37 AND IS BASED ON APPLICATION NO.~~

21	01	

THIS APPLICATION IS ACCOMPANIED BY:

- ☒ 1. A single copy of a provisional specification of 10 pages.
- ☒ 2. Drawings of 2 sheets.
- ☐ 3. Publication particulars and abstract (Form P.8 in duplicate).
- ☐ 4. A copy of Figure of the drawings (if any) for the abstract.
- ☐ 5. Assignment of invention.
- ☐ 6. Certified priority document.
- ☐ 7. Translation of the priority document.
- ☐ 8. Assignment of priority rights.
- ☐ 9. A copy of the Form P.2 and the specification of S.A. Patent Application No .
- ☒ 10. Declaration and power of attorney on Form P.3.
- ☐ 11. Request for ante-dating on Form P.4.
- ☐ 12. Request for classification on Form P.9.
- ☒ 13. Form P.2 in duplicate.
- ☐ 14. Other.

74	ADDRESS FOR SERVICE: SPOOR & FISHER, SANDTON

Dated: 16 July 2002

SPOOR & FISHER
PATENT ATTORNEYS FOR THE APPLICANT(S)

REGISTRAR OF PATENTS, DESIGNS, TRADE MARKS AND COPYRIGHT
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2002 -07- 16
REGISTRATEUR VAN PATENTE, MODELLE, HANDELSMERKE EN OUTEURSREG

REGISTRAR OF PATENTS

SPOOR & FISHER

FORM P.6

REPUBLIC OF SOUTH AFRICA
PATENTS ACT, 1978

PROVISIONAL SPECIFICATION

(Section 30(1) – Regulation 27)

OFFICIAL APPLICATION NO.			LODGING DATE	
21	01	2002/5663	22	16 JULY 2002

FULL NAMES OF APPLICANTS

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14 . 07 . 2003

TITLE OF INVENTION

54	FUEL THEFT DETECTION SYSTEM AND METHOD

BACKGROUND OF THE INVENTION

THIS invention relates to a fuel theft detection system and method.

The theft of fuel is a rampant problem that costs the transport industry vast amounts of money. There are several methods in which fuel is stolen, including fuel being siphoned from a vehicle's fuel tank, the owner of a vehicle or a fleet of vehicles being overcharged for the actual quantity of fuel that has been dispensed to the vehicle(s), or where a single fuel payment card is used to dispense fuel to a number of different vehicles.

Typically, the second and third ways described above of stealing fuel take place where the driver of the vehicle and/or the fleet manager are/is in collusion with the workers and/or owners of filling stations. The second method, namely overcharging, is particularly common as fuel gauges are generally not very accurate in terms of confirming a vehicle operator's claim that he or she filled the vehicle's fuel tank completely. Thus, the vehicle's owner will pay for a full tank of fuel, say, 60 litres, whereas in fact only 50 litres was pumped into the vehicle. The owner is none the wiser because generally fuel gauges are not sufficiently accurate to indicate that the fuel tank is only, for example, 90% full, and not 100% full as claimed. In addition, it is impractical

for the owner to check each and every vehicle that has just been filled with fuel.

There are several systems presently available that seek to address the problem of fuel theft. The most accurate of these systems involves measuring the actual amount of fuel that has been combusted by the vehicle's engine. Thus, for example, in a diesel powered vehicle this involves measuring the flow of fuel before it enters the injector pump and the flow of excess fuel back to the tank. Whilst this system is relatively accurate, it is generally prohibitively expensive, and, it is believed, can be manipulated if the fuel tank is not filled completely or the flow of fuel is intercepted and redirected between the device and the injector pump.

A second system of preventing fuel theft takes the form of a sleeve that is simply inserted into the neck of the fuel tank, which serves to prevent the insertion of a siphon, thereby preventing the siphoning of fuel directly out of the fuel tank. The primary problem with such a system is that fuel can still be removed from the fuel tank via, for example, the drain plug of the fuel tank, by removing the fuel level meter cap, or from the fuel line directly.

Other systems that are aimed at preventing fuel theft involve fitting an electronic vehicle identification unit around the neck of the fuel tank. The nozzle of the fuel pump is in turn also fitted with an electronic device, with the two devices being programmed so that the fuel pump will only dispense fuel if the vehicle identification unit on the vehicle's fuel tank is actively identified. The resulting transaction is then recorded, and is thus relatively foolproof. There are however certain limitations with this system, with the primary one being that fuel can still be siphoned from the fuel tank.

It would therefore be desirable to provide a fuel theft detection system and method that addresses the abovementioned problems.

SUMMARY OF THE INVENTION

According to a first aspect of the invention there is provided a fuel theft detection system for detecting when fuel has been stolen from a vehicle's fuel tank, the system comprising:

> input means that is connectable to a vehicle's fuel level sensor for providing an indication of the fuel level in the vehicle's fuel tank;
>
> a controller connected to the input means;
>
> timing means for driving the controller to capture and record the fuel level at regular, pre-determined intervals; and
>
> storage means for storing the recorded data,

wherein the controller is arranged to calculate the average fuel level over a first period of time, and to then store the resulting average fuel level in the storage means for later analysis, so that any deviation in the fuel level in successive periods of time by more than a predetermined amount would suggest fuel theft.

Advantageously, the system includes a reference voltage defining means for defining a reference voltage that corresponds to a truly full fuel tank. Preferably, the reference voltage is permanently stored.

Alternatively, the controller could be pre-programmed with the characteristics, including the reference voltages, of all existing fuel gauge sensors.

Typically, the input means produces an analogue signal indicative of the fuel level, with the system further including an analogue to digital converter for

converting the analogue voltage signal into a digital signal, the resulting digital signal defining a primary input for the controller.

Preferably, the timing means is an oscillator, with the regular, pre-determined interval being approximately 10 seconds.

Typically, the system is connected in series between a vehicle's ignition switch and the vehicle's fuel level sensor in the fuel tank.

Conveniently, the system is powered by the vehicle's battery via a power supply module, the module including a filter for eliminating voltage fluctuations and a regulator for regulating the DC voltage from the battery.

According to a second aspect of the invention there is provided a fuel theft detection method for detecting when fuel has been stolen from a vehicle's fuel tank, the method comprising the steps of:

> sensing fuel level in the vehicle's fuel tank;
>
> capturing and recording the fuel level at regular, pre-determined intervals;
>
> storing the recorded data;
>
> calculating the average fuel level over a first period of time; and
>
> storing the resulting average fuel level for later analysis, so that any deviation in the fuel level in successive periods of time by more than a predetermined amount would suggest fuel theft.

Advantageously, the method includes the step of defining a reference voltage that corresponds to a truly full fuel tank. Preferably, the reference voltage is permanently stored.

Alternatively, the controller could be pre-programmed with the characteristics, including the reference voltages, of all existing fuel gauge sensors.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 shows a schematic circuit diagram of a fuel theft detection system according to the present invention;

Figure 2 shows a schematic diagram of how the system shown in Figure 1 is connected to a communications network that would allow transmission of information obtained by the fuel detection system to a base station; and

Figure 3 shows an example of a record that would be produced by the system shown in Figure 1 for assisting in the detection of fuel theft.

DESCRIPTION OF EMBODIMENTS

Referring to Figures 1 and 2, a fuel theft detection system 10 is shown connected in series between a vehicle's battery 12 and a vehicle's fuel level sensor 14 in a fuel tank 16. The fuel level sensor 14 is in turn connected to the vehicle's fuel gauge and drives the fuel gauge so as to provide a visual

indication to the driver or operator of the vehicle of the amount of fuel in the fuel tank 16 at any particular moment. Significantly, the fuel level sensor 14 thus provides a sensor input, in the form of a voltage waveform indicative of the fuel level in the tank 16, to the system 10.

The system 10 includes a filter and delay circuit 18 for filtering the incoming voltage waveform, and an analogue to digital converter 20 for converting the incoming analogue voltage signal into a digital signal. The resulting digital signal defines a primary input for a peripheral interface controller 22.

Additional inputs for the controller 22 include a calibration module 24 for allowing the system 10, and in particular the controller 22, to be provided with upper and lower reference voltages corresponding to a truly full fuel tank and to a truly empty fuel tank. These values vary according to the fuel level sensor 14 being used in fuel tank 16, and will typically be measured and stored in the controller 22 during the installation of the system 10 a vehicle. Alternatively, these reference voltages for a variety of fuel level sensors could be pre-programmed into the controller 22, so that upon installation of the system 10 into the vehicle, the appropriate values can be selected and stored in the controller 22. The significance of these upper and lower reference voltages will be described in more detail further on in the specification.

An 8 V power supply rail 26 powers the controller 22 via ignition switch 27. In particular, the system 10 is powered by the vehicle's battery 12 via a power supply module 28. The module 28 includes a filter to eliminate voltage fluctuations that would occur, for example, when the vehicle's indicators are being operated, as well as a regulator for regulating the DC voltage to the controller 22.

A further input into the controller is an oscillator 30, which serves to drive the controller 22 so that every 10 seconds the voltage of the fuel level sensor 14 is

captured and transmitted to an output buffer 32. The buffer 32 serves to temporarily hold the data that is transmitted between the controller 22 and a peripheral storage device 34 via serial data output line 36.

The peripheral storage device 34 will typically take the form of an existing recording device within the vehicle, such as a tachograph, an on board computer or a fuel management system, for example. If the vehicle is not provided with such a recording device, a dedicated recording device or any of the storage devices mentioned above would need to be fitted to the vehicle in order to record the serial data.

Typically, the data that is sent through to, and stored in, the peripheral storage 34 device is first encoded by the controller 22. The output buffer 32 has a number of additional digital outputs 38 that could, for example, be used to provide the status of the system 10 to the driver or operator of the vehicle by means of an on-board console.

In use, the fuel level sensor 14 is continuously monitoring the fuel level in the fuel tank 16, with the controller 22 ultimately receiving a digital signal corresponding to the fuel level. Approximately every 10 seconds, the voltage transmitted by the sensor 14 is recorded and stored in the output buffer 32. After one minute, the average voltage of the 6 voltage readings that have been stored in the buffer 32 for that particular minute, referred to as the minute average, is calculated by the controller 22 and also stored in the output buffer 32. After 5 minutes, an average of the 5 one minute averages, referred to as a cycle average, is calculated by the controller 22 and transmitted to, and stored in, the peripheral storage device 34.

The purpose of obtaining average values is to compensate for fluctuations in the fuel level as a result of, for example, the vehicle being positioned on an incline or turning a corner, etc. Clearly, the figures provided above, namely 10

seconds, every minute, and after 5 minutes, are all examples and are merely provided to assist in explaining the operation of the present invention.

In the preferred embodiment, the peripheral storage device 34 is fitted with a transmitter 40 that will transmit the data stored in the device 34 to a first receiver 42. The first receiver 42 will typically be situated at the grounds where the vehicle is kept when not in use. It is envisaged that the data could then be transmitted to a second receiver 44, situated at a base station, where a third party would store and analyse the received data and notify the vehicle owner when it has been suspected that fuel has been stolen.

The data stored in the storage device 34 can be plotted and thus analysed. An example of such a graph is shown in Figure 3, with the x-axis corresponding to time and being set out in 5 minute intervals, and the y-axis corresponding to the level of fuel in the tank, and in particular discrete voltage values. The gradient of this graph would thus give an indication of the fuel consumption of the vehicle.

The graph is flat over the first 3 time intervals because it normally takes a while for fuel gauge sensors to sense a drop in the fuel level. However, fuel theft could still be detected during this period by extending the point at which the first fuel level drop is detected, which in this case occurs at interval no. 4, back towards the first value that was detected, as indicated by broken line 46. If the gradient of this line 46 is approximately equal to the gradient of the lines during normal vehicle usage, such as between intervals 4 and 7, 10 and 13 and 18 and 20, then it could be concluded that no fuel theft took place during this period.

The breaks in the graph between intervals 7 and 10, 15 and 18, and 20 and 22 indicate that the vehicle was switched off during these intervals. It would be expected for the fuel level to stay the same before and after the vehicle has

been switched off, and is true for the breaks in the graph between intervals 7 and 10, and between 20 and 22. However, the fuel level drops between intervals 15 and 18, which suggests that fuel was stolen whilst the vehicle was off during this period.

If fuel is stolen whilst the vehicle is running, the graph would follow the curve indicated between intervals 13 and 15. This deviates significantly from line 48, which is what the graph between these two points would resemble had there not been fuel theft. Thus, by monitoring the fuel level for each 5 minute cycle, any deviation in the fuel level by, for example, 4 % in a given cycle will suggest a discrepant rate of fuel consumption, and thus the possibility of fuel theft.

Lastly, at interval 22, it can be seen that the tank was filled with fuel. Assuming that the tank is fully filled, the value y_1 on the graph corresponds to the upper reference voltage described above. The value y_2 would be sufficiently close to the lower reference voltage described above to allow the quantity of fuel that has been pumped into the fuel tank to be relatively accurately calculated. This can then be compared to the quantity of fuel billed. Any discrepancy will indicate that the owner of the vehicle has been charged for fuel that was in fact never put into the fuel tank 16. Thereafter, the owner will know which operator or driver to monitor, with the owner then being in a position to take appropriate action based on the data obtained by the system 10 of the present invention.

The controller 22, as mentioned above, is calibrated to indicate a tank 16 that is truly full, thereby eliminating the possibility of a vehicle operator claiming to have fully filled the tank 16 but in fact not having done so. A brief review of the data recorded by the storage device 34 will quickly reveal whether the vehicle was filled with fuel within a specific period of time. Thus, if the vehicle's owner knows, for example, that 12 V (i.e. the reference voltage) corresponds to a full

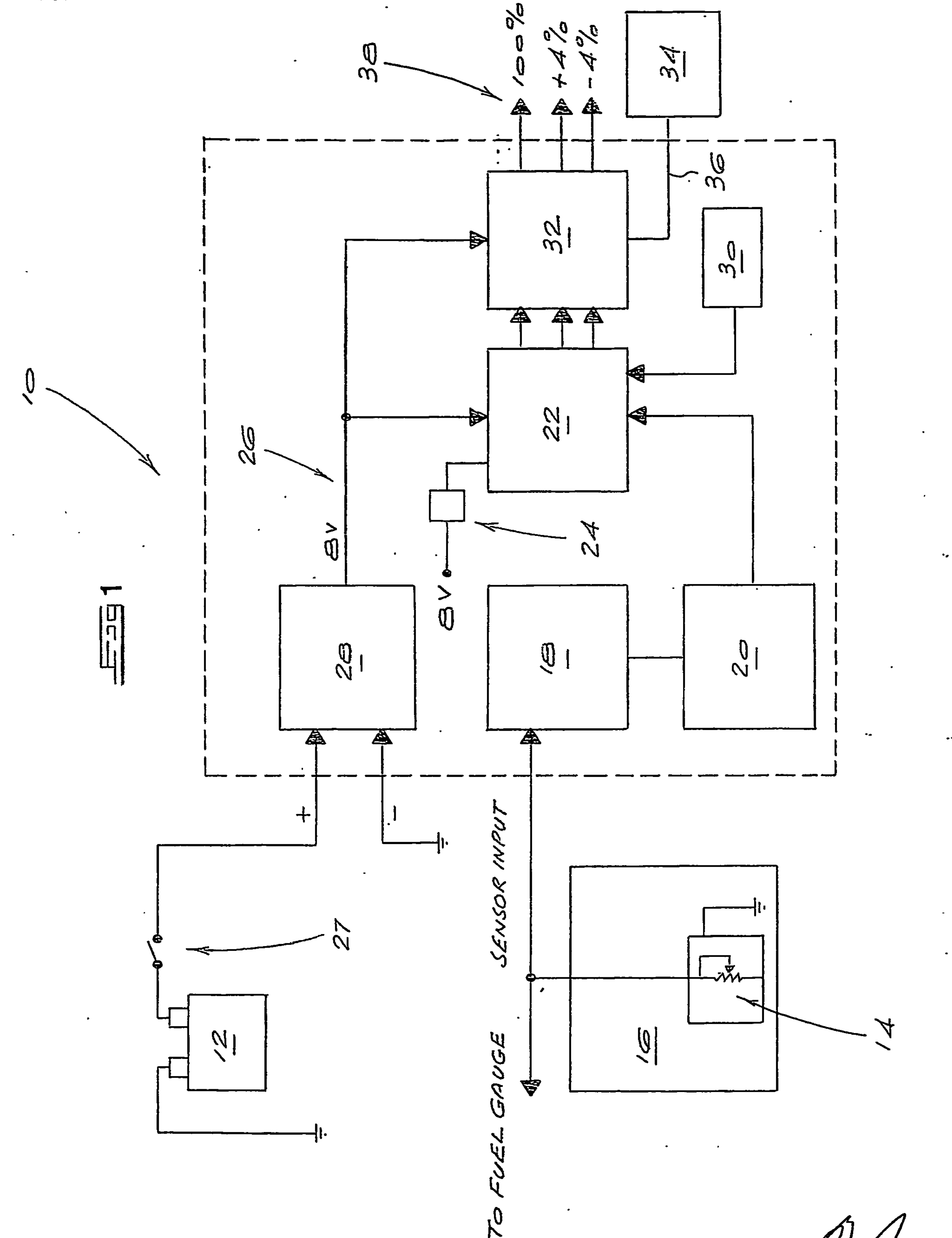
tank, and after the operator claims to have fully filled the tank 16, the voltage is only 11 V, there is a strong suggestion that fuel has been stolen.

DATED THIS 16th DAY OF JULY 2002

SPOOR & FISHER
APPLICANT'S PATENT ATTORNEYS

2002/5663

POTGIETER, JOHANNES H[illegible]MANUS; FOURIE, PATRICK DESMON[illegible] 2 SHEETS
PROVISIONAL SPECIFICATION SHEET 1



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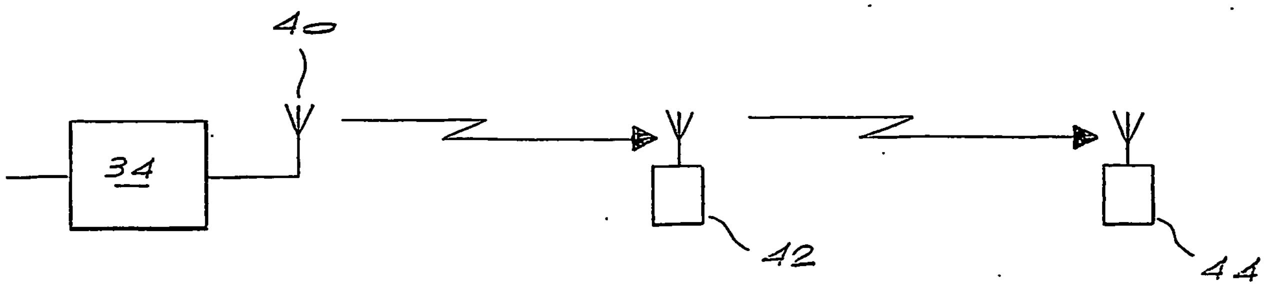

FIG 2

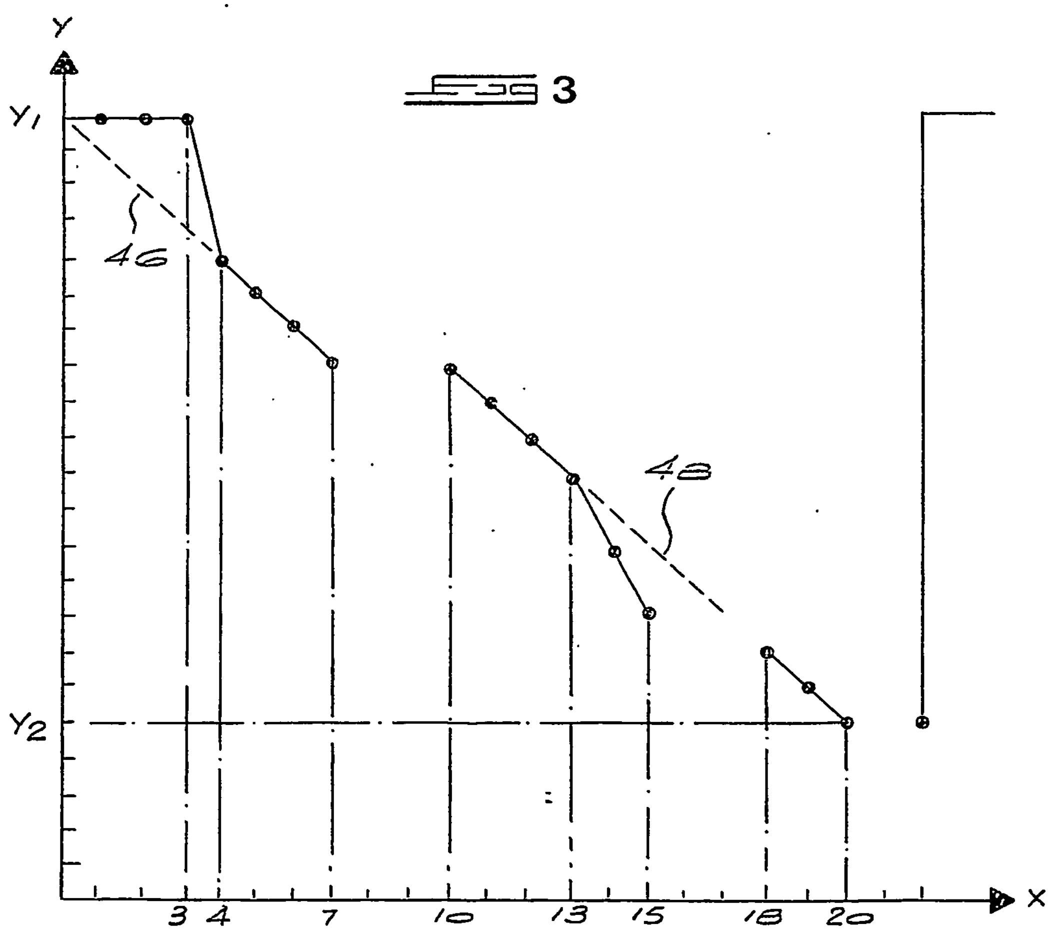

FIG 3

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